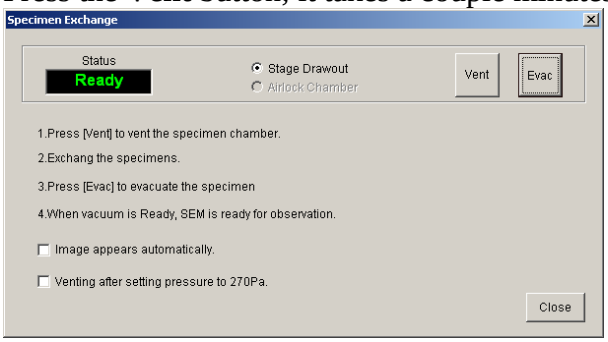
BASIC Step-by-Step Instructions for JEOL 6060LV

Version 4/13/11

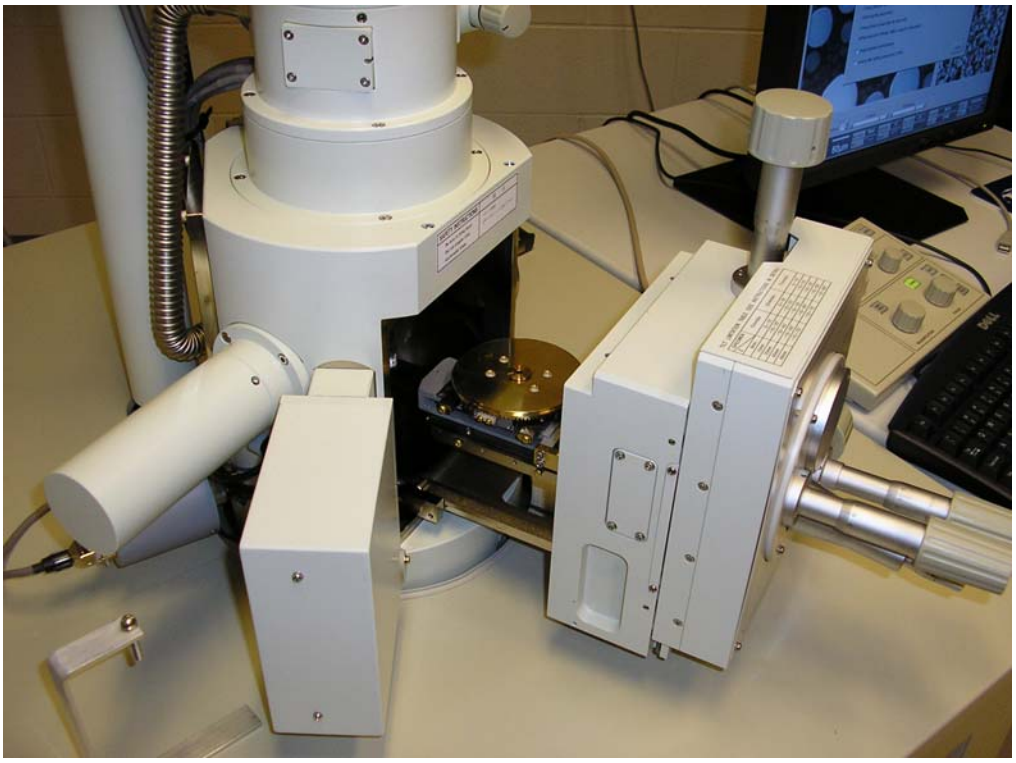
General Operation

1. Check System: Pumps running and EVAC light green (main panel near key switch)? If not notify a staff member.
2. If the SEM software is not running, start SEM Software (**SEM Main Menu** icon). It takes several minutes to start, be patient. If you need to log into computer use the account (USER:jeol;PASSWORD:jeol). Please do not log into other accounts. Use portable media, ftp, or UIUC NetFiles to transfer your data.
3. Prepare your samples before venting! Please keep the area clean, organized, and wear GLOVES!! Anything that goes in the vacuum should be clean and handled only with gloves or tweezers; keep the vacuum clean.
4. Press the **Sample**

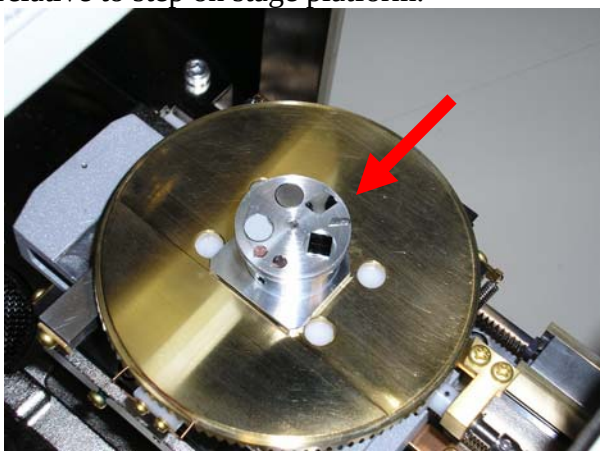
button on toolbar.
5. Press the **Vent** button; it takes a couple minutes to vent.



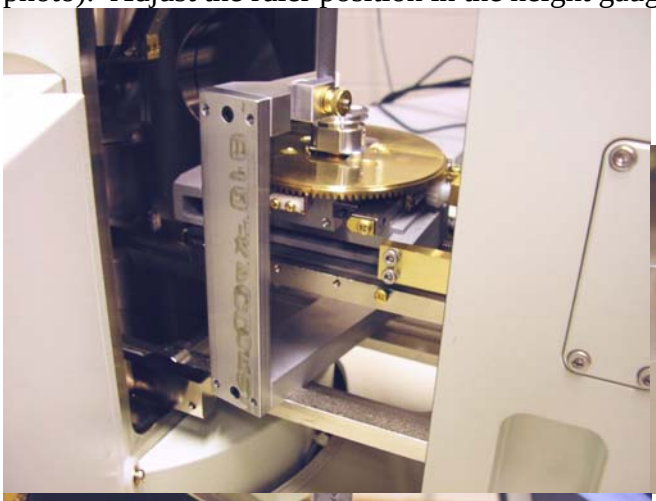
6. When Vent light stops blinking (main panel near key switch), slide open stage drawer.

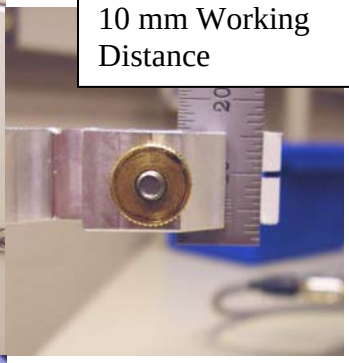


7. Slide sample holder onto stage dovetail. Note proper direction to slide on “dovetail” relative to step on stage platform.



8. Adjust sample height (Working Distance) using height gauge. 10 mm is the EDS working distance. Bottom end of ruler corresponds to the working distance (see photo). Adjust the ruler position in the height gauge for desired working distance.





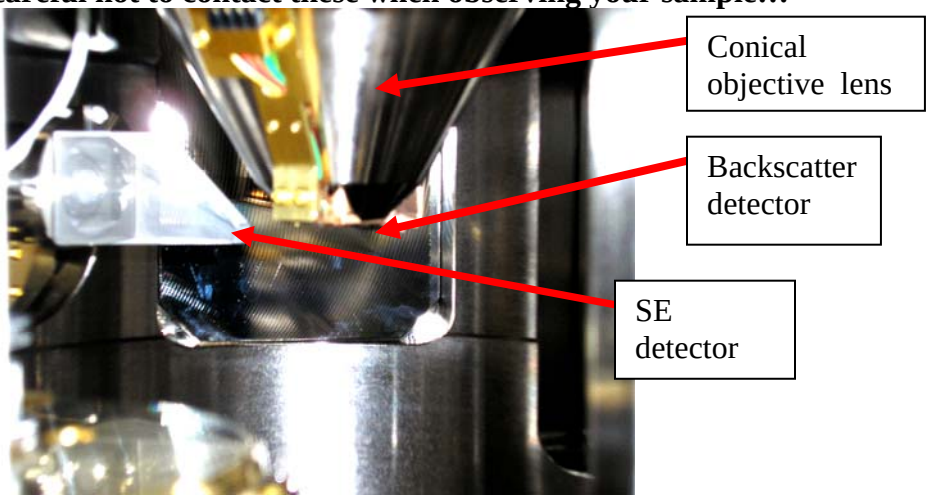
Ruler Adjusted for 10 mm Working Distance

No part of the sample should extend above the ruler end. A 10 mm W.D. should be used for nearly all work except low magnification imaging or if you need to tilt more than 15 degrees. Working distances up to 48 mm can be used to attain magnifications as low as 5x and/or better depth of focus. Working distances shorter than 8 mm should never be used! A barrier has been installed to prevent inserting a sample set too high.

9. Specimen tilting is limited by working distance and specimen diameter. ***The IR chamber-scope must be used for sample tilting and Z adjustment to verify that safe clearance with detectors, etc. is maintained.*** Safe clearance is at least 5mm distance on LCD monitor. The following table shows the typical Allowable Tilt Range for samples up to 32 mm diameter. Larger samples are more restricted. This assumes no part of sample is higher than indicated Working Distance.

Working Distance	Allowable Tilt Range
10 mm	0 to 15 degrees
15 mm	-10 to 15 degrees
20 mm	-10 to 35 degrees
40 mm	-10 to 65 degrees
48 mm (max W.D.)	-10 to 70 degrees

Note: The Backscatter detector and SE detector are very delicate and will be damaged by any contact with a sample (>$3000 to repair). You must be extremely careful not to contact these when observing your sample!!!



10. Turn on the IR chamber-scope, if off, using the switch (button) on the control box and a switch on CRT monitor and adjust illumination as needed. **Always use chamber-scope for tilt and Z adjustment of sample during operation. Note: The chamber-scope illumination does not interfere with SEI but must be turned off for BEIW modes and EDS operation.**

11. **Carefully (slowly) slide the stage drawer closed, while verifying safe clearance of sample on chamber-scope.** Press **EVAC** button on the Specimen exchange dialog box. Hold the door closed until pumping starts (it takes a few seconds).

12. In about 1.5 minutes, the HT icon turns to **HT ready**.

Wait at least 2 more additional minutes!!

13. Select the desired accelerating voltage (up to 30 kV)

. Double click on new value to change setting.
14. Set the working distance (similar to previous step). Just select the working distance you preset the sample for (usually 10 mm).

15. Set the Signal to **SEI**

, if not already
(You can change it to **BEIW**, if desired later).

16. Click the **HT Ready**

icon to turn on the High Voltage, now should be

Some intensity should be seen in the image window. If not press **View**

and **ACB**

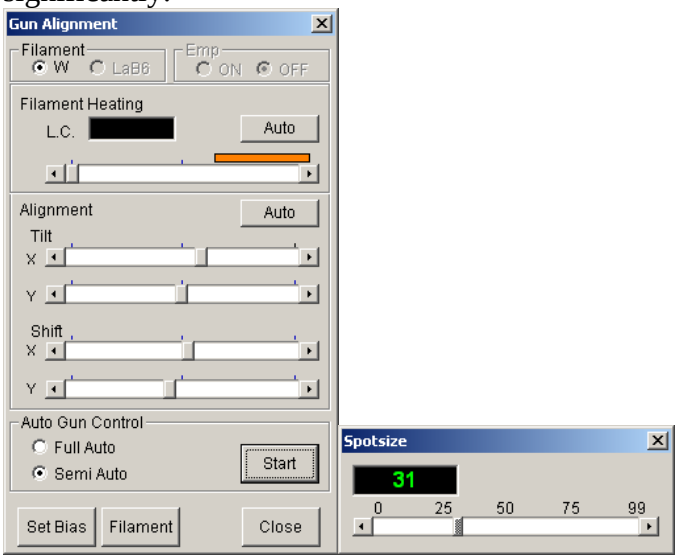
. **ACB** takes several seconds to run. Something should be visible on the screen now.

17. Click the **Gun** icon

. The electron gun and alignment dialog appears.

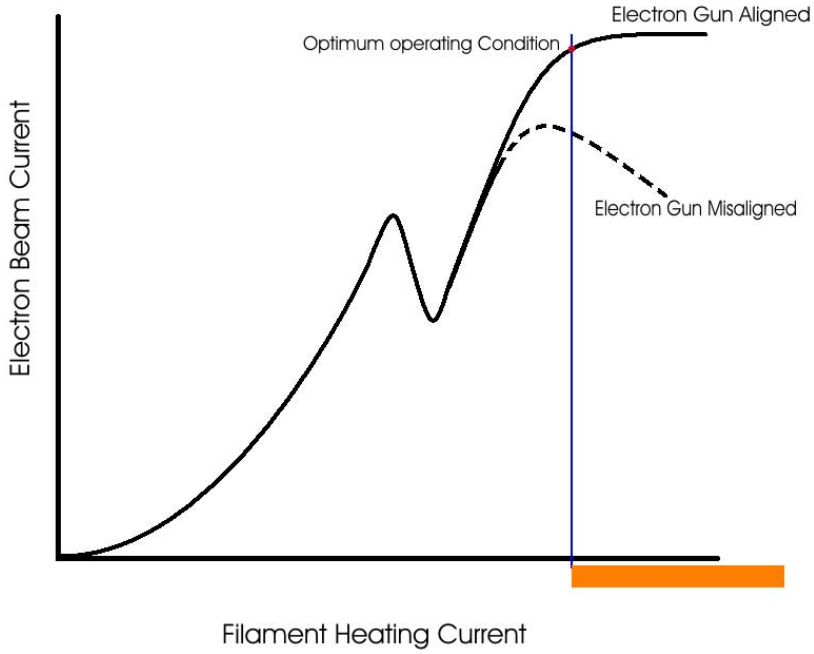
There are a couple of options at this point depending on skill level, needs, etc. Basically you need to check gun alignment and then filament saturation.

Recommended Procedure: Manually perform this task. It only takes a minute and will insure optimized operation and best images. Note: We do NOT use Auto filament heating or Auto Gun Control. We found the use of these seem to shorten filament life significantly.



a. Select an area on the sample or sample holder that has reasonably homogeneous brightness at moderate magnification (1-5 kx)
b. Adjust Tilt X and Y for maximum average image brightness at a low Spot Size setting (<=20) by iteration.
c. Adjust Shift X and Y for maximum average image brightness at a high Spot Size setting (=>60). **ACB** or manual adjustment of brightness/contrast will likely be needed as the image brightness will usually saturate. If intensity disappears before reaching Spot Size 60, adjust shifts at highest spot size you still have an image, then increase to above 60 and adjust again. Again iterate controls to optimize.
d. Steps b and c can be iterated to optimize alignment. This is usually not necessary unless large adjustments in the first pass were required.

e. Manually check filament saturation. This is best done at a higher spot size setting (40-60) and a high contrast setting. Click the Filament Heating down arrow (left side of slider control) several times until you see the average brightness decrease somewhat. Click the Filament Heating up arrow one step at a time while noting the change in brightness. **The slider might fully overlap and slightly past (<1mm) the left edge of the orange bar for new filaments. It should never be set higher!** The average brightness should increase with each step but the change between steps decreases. At the step where there is virtually no perceptible increase, click the down arrow two-three times. There should be a very slight decrease in average brightness. The filament is now properly saturated. Note: If brightness decreases after going through a maximum (before beginning of orange indicator), the gun tilt/shifts are misaligned. This is usually because the filament was significantly under saturated when you started. Restart the procedure, with the right edge of the slider lined up with the orange bar.



Quick and Simple Modification:
Simplified procedure, especially useful, where you do not want to expose sample to high probe currents. Works well when starting point is correct or almost correct.

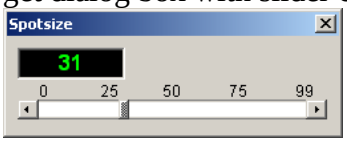
a. Just adjust both Tilt X and Y and Shift X and Y at a selected spot size setting (the value you're going to use) for maximum average brightness. A noisy image (low spot size values), however, makes this more difficult. You could increase the averaging in the scans setup dialog to decrease the noise but remember the response time will be slower.
b. Perform step e above.

Note: **Auto Alignment (Auto** button in Alignment box**)** may be run at any time but is usually not necessary (manual alignment is more reliable and just as fast to do). When

running auto alignment first select an area on the sample or sample holder that has homogeneous brightness at moderate magnification (1-5 kx) to get the best beam alignment.

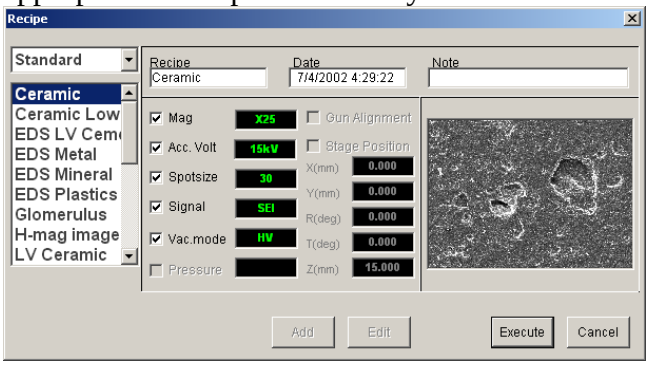
18. Select a spot size, usually initially between 30 and 40. Click

to get dialog box with slider control. Usable range is about 10~75.



19. If desired, chose a pre-defined **Recipe** to set microscope conditions

(you may switch to LV mode by selecting an LV recipe). This is a very good way to set appropriate SEM parameters if you don't know what you want.



Select the desired recipe and click execute.

20. Click **View**

{sets fast scan (same as Scan 2) at very low magnification (30X)}. At this point, you could also select Scan 2 and move stage to area of interest an select a relatively low magnification (features still visible although they may be out of focus).
21. Click **ACB**

(auto contrast brightness).
22. **Focus and check the objective aperture centering**, especially for high magnification work.
23. **Fine focus and correct the astigmatism the image manually** or click **Auto Focus**

or **Auto Stigma**

(auto focus and auto stigmator). On many samples auto focus and auto stigmate actually will fail or will not be exact. Usually you need to manually focus and stigmate especially at higher magnifications. ***Almost always you need to fine tune focus and stigmators manually!!*** These functions are, of course, available on the knob pad. You also need to check and, if needed, adjust the ***objective aperture centering***. See the next step and individual procedures in the rest of the manual for details on how to perform these operations.

24. **Observe your sample**
    a. *If the image shifts when manually focusing, align the objective aperture. Adjusting this will always cause the astigmatism correction to change!*
    b. *If the image focuses asymmetrically or with stretching or streaks, correct the astigmatism.*

c. *Hint: For easier operation, in HV mode, use the SEI detector to set up the instrument and focus, etc. Switch to the BEIW mode mostly to look at or record slow scan images.*
d. *If you are working at high magnification, select a smaller spot size for a sharper image. If the image is too noisy select a larger spot size. Remember there is a trade off between noise (fast scanning) and attainable resolution.*
e. *Tilt and Z must be adjusted only if you are sure it is safe to do so (do not run into detectors!!).* ***Use the IR chamber-scope always for these adjustments!!***
f. *Scan Rotation is available (***SRT icon***). This is very useful for orientating the image the way you want without rotating the stage (be aware the perception of the image can change due to the apparent direction of oblique illumination changing (relative position of the detector). It is also very useful for working with cross-section samples (changing the orientation of the tilt axis).*
g. *Watch out for* **Tools → Neutralizer** *being checked. When neutralizer mode is selected the voltage on the collector grid is changed. This mode reduces secondary electron collection of the lowest energy electrons and may help with some kinds of charging artifacts.*
h. *Many commonly used functions are available on the knob panel (magnification, brightness, contrast, stigmator x and y, image fine shift x and y, scanning mode, and auto functions {focus, stigma, contrast brightness}).*
i. ***Scan4*** *(80 seconds) will automatically freeze at end of frame to save image. While scanning the image observed is just a preview, the actual image quality is much better (just watch the image as the scan finishes, then press the* ***Zoom*** *button)*
j. ***Scan3*** *(10 or 20 seconds) will freeze at end of frame if freeze is clicked.*
k. ***Photo*** *(160 seconds) can be used to decrease noise and get the best possible quality.*
l. *Saved images are 1280 x 960 pixels.*
For Scan3 the images are 640 x 480(10 sec) or 1280 x 960 (20 sec pixels).
m. *In the* **Save** *Image dialog box there is a check box,* **Merge Text***. When this is checked the saved image will have the data area text embedded in the image.*
n. *Displayed images are 640 x 480. Click Zoom on frozen image to see full resolution image (1024 x 768) or (1280 x 960 with pan).*
o. *Measuring functions are available under the Image menu for a frozen image. The measurements can be burned into the image with the* **Write** *button prior to saving the image.*
p. ***SIS AnalySIS*** *software (on SEM computer) can be also used to do image measurements.*
q. ***ImageJ (Java version of NIH Image)*** *is free software which also can be used for image analysis on your own computer.*

Changing Samples or Ending Your Session

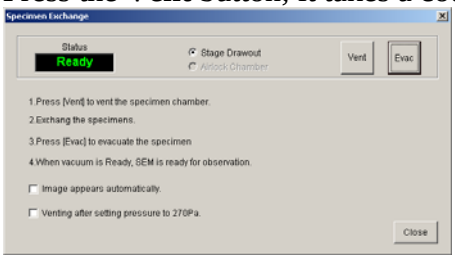
1. Turn off the High Voltage (click **HT On**

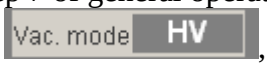
control on main panel,

   it should change to **HT ready**

)
2. ***Wait 2 minutes!!***
3. Press the **Sample** button on toolbar.

4. Press the **Vent** button; it takes a couple minutes to vent.



5. When Vent light (on the main chassis) stops blinking, slide open stage drawer
6. If changing samples, go to step 7 of general operation
7. Change vacuum mode to HV 

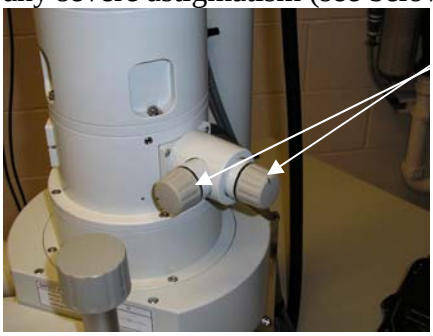
, if in LV mode.
8. Carefully slide the stage drawer closed. Press EVAC button on the Specimen exchange dialog box. Hold the door closed until pumping starts (it takes a few seconds).
9. **Fill out the instrument log!**
10. Wait until the HT icon turns to **HT ready** (about 1 min. 30 sec)

.
11. You can now leave. Lock the door and turn off the lights, as appropriate.

Aligning the Objective Aperture

1. This procedure needs done if the image shifts in any direction when going through focus.
2. Center a distinct feature in the field of view (>5000x)
3. Select **Wobb**

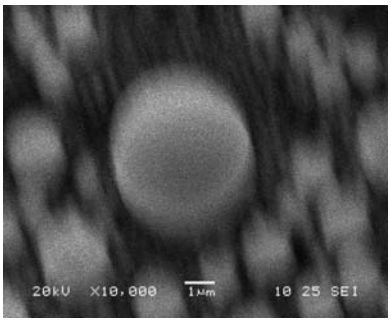
(the image should now modulate in focus) and Scan1 is automatically selected
4. Adjust Aperture X and Y controls to minimize lateral motion of feature.
   Hint: Determine what direction one of the translation controls has the most effect by over-adjusting a little and then adjust so that the residual motion is perpendicular to that direction. Then adjust the other translation control. Iterate to fine tune. Correct any severe astigmatism (see below) to be able to better fine tune

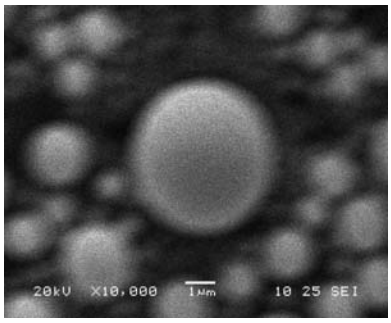


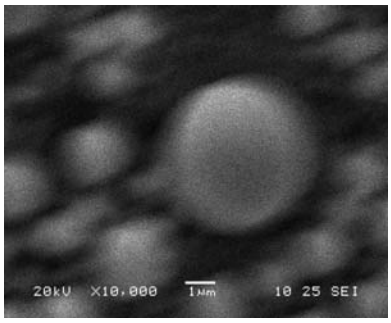
Objective aperture X and Y adjustment knobs

5. Deselect **Wobb**

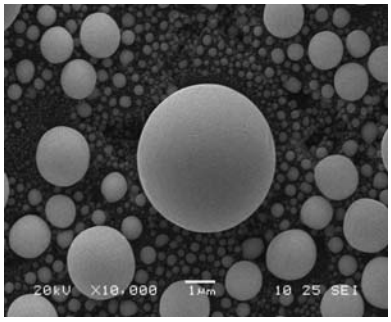
Manually Correcting the Astigmatism







Above: sequence of images at under-focus, near focus, and over-focus conditions with significant objective astigmatism



Left: An image in focus and fully corrected astigmatism

Note: You need an image with edge features in nearly all directions! If necessary find a feature on your sample, such as a dust or contamination particle

1. Select **Stig** on ***Knob Panel*** (lights green)
2. Adjust X and Y control knob on panel for best image
3. Adjust focus for best image
4. Iterate steps 2 and 3 until your satisfied the image cannot be improved more.

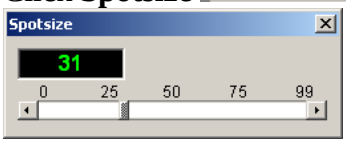
5. If the image is not sharp enough, try decreasing the spot size, and verify the sample is at a working distance of 8-10mm. Also lower kV operation will yield slightly poorer resolution.

Manually Adjusting Brightness and Contrast

1. Deselect **Stig** on ***Knob Panel*** if lit green
2. Adjust using rotary controls.
3. Adjustment may also be done manually with mouse (see software help files)
4. If Brightness/Contrast is far off (saturated black or white) use **ACB** to do a coarse adjustment, before fine tuning manually.

Selecting a Spot Size

1. Click **Spotsize**

(A dialog with a slider should appear)


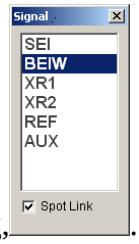
2. Adjust slider to desired spot size
3. Very high (large) spot sizes should generally not be used (>60). They give poor resolution and may damage your sample. They can be used if you know that's what you want.

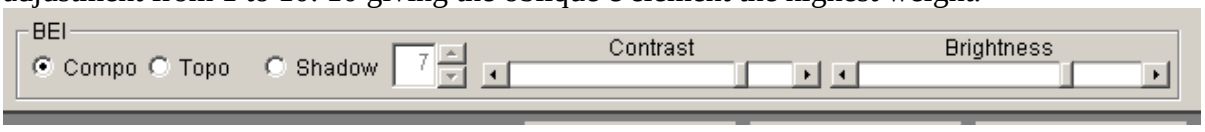
   A spot size of around 10 @ 30 kV is the condition the instrument provides it's best resolution (100 kX possible). This is a fairly noisy image even on a Au/C sample. You must choose the spot size according to your sample and what level of resolution you need. With too low of spot size you may be unnecessarily forcing yourself to work with noisy images or having your saved images with extra noise.

Large spot size => higher e⁻ current => more signal => less noise => poorer resolution
Small spot size => lower e⁻ current => less signal => more noise => better resolution

Selecting the Image Signal

1. Click **Signal**

to get the dialog, 

.
   Double Click on **BEIW (backscattered electron image)** or **SEI (secondary electron image).** None of the other choices are currently used.
2. **BEIW** has three modes (COMPO, TOPO, SHADOW). Shadow has a weighting adjustment from 1 to 10. 10 giving the oblique c element the highest weight.


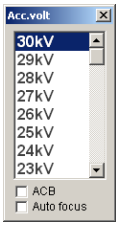
   a. **COMPO** (a+b) – normal BSE image, compositional contrast
   b. **TOPO** (a-b) – topographical image, potentially very noisy image unless the sample has large topography

c. **SHADOW** (a+b+c) – image with strong oblique component, image similar to SEI but with BSE, needed for LV mode where SEI detector does not function

The Solid State BSE detector is fairly "slow", therefore at fast scan speeds the image is "blurred" in the raster direction. This does not occur at slower scans but makes focus/astigmatism correction a little more difficult to do. **ACB** and manual knob adjustment function in all the **BEIW** modes

Selecting the Operating Voltage

1. Click **Acc. Volt**

to get 

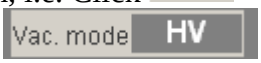
2. Double Click value to be selected

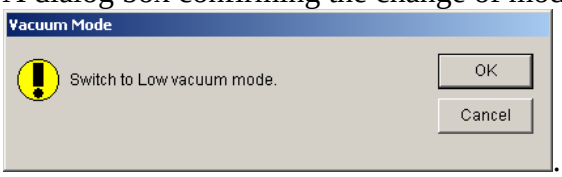
The best accelerating voltage to use is very sample and information dependent. The appearance of and information contained in an image taken at 1-5 kV can be very different from the "same" image at 20-30 kV. This is especially true for imaging low density (e.g. porous) and/or low-Z (atomic-#) surfaces.

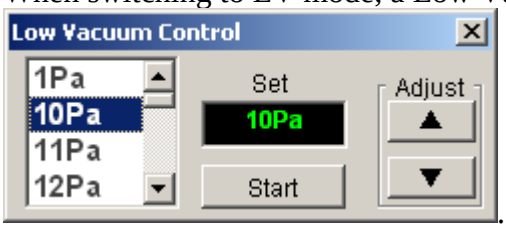
Changing the Vacuum Mode

LV mode is generally used to observe and analyze non-conducting sample without the need for a conductive coating (Au/Pd or C).

1. Turn off the Beam, i.e. Click

2. Click **Vac. Mode** 

A dialog box confirming the change of mode should appear.


.
3. Click **OK**
4. When switching to LV mode, a Low Vacuum Control Dialog box appears.


.
5. An operating pressure of ***1 to 270 Pa*** (2 torr) can be selected.
6. When **HT Ready**

re-appears, click it to restore the e-beam (

)
LV mode can be used to look at and analyze uncoated non-conductive samples without charging artifact and imaging problems. It can also be used to observe wet or badly out-gassing samples, but this requires addition procedures (wet). In general, use as low as pressure as possible that works for imaging the sample (1 to 10's of Pa). Again **BEIW-Shadow** mode provides secondary electron like images. Since the e-beam will interact with the gas in the specimen chamber, increasing pressure will result in a signal decrease and the resolution will get poorer. Also, longer working distances generally will not work well in **LV mode**.

Starting with LV vacuum mode (sample is not suitable for HV vacuum mode)
Change mode to LV before pressing EVAC. Automatic gun alignment functions do not function in LV mode. Strongly suggest verifying proper operation/alignment in normal HV mode first (even if it is just on the stage, i.e. no sample)

Improving Depth of Focus or Obtaining Lower Magnifications
Move sample to a longer working distance.

Troubleshooting

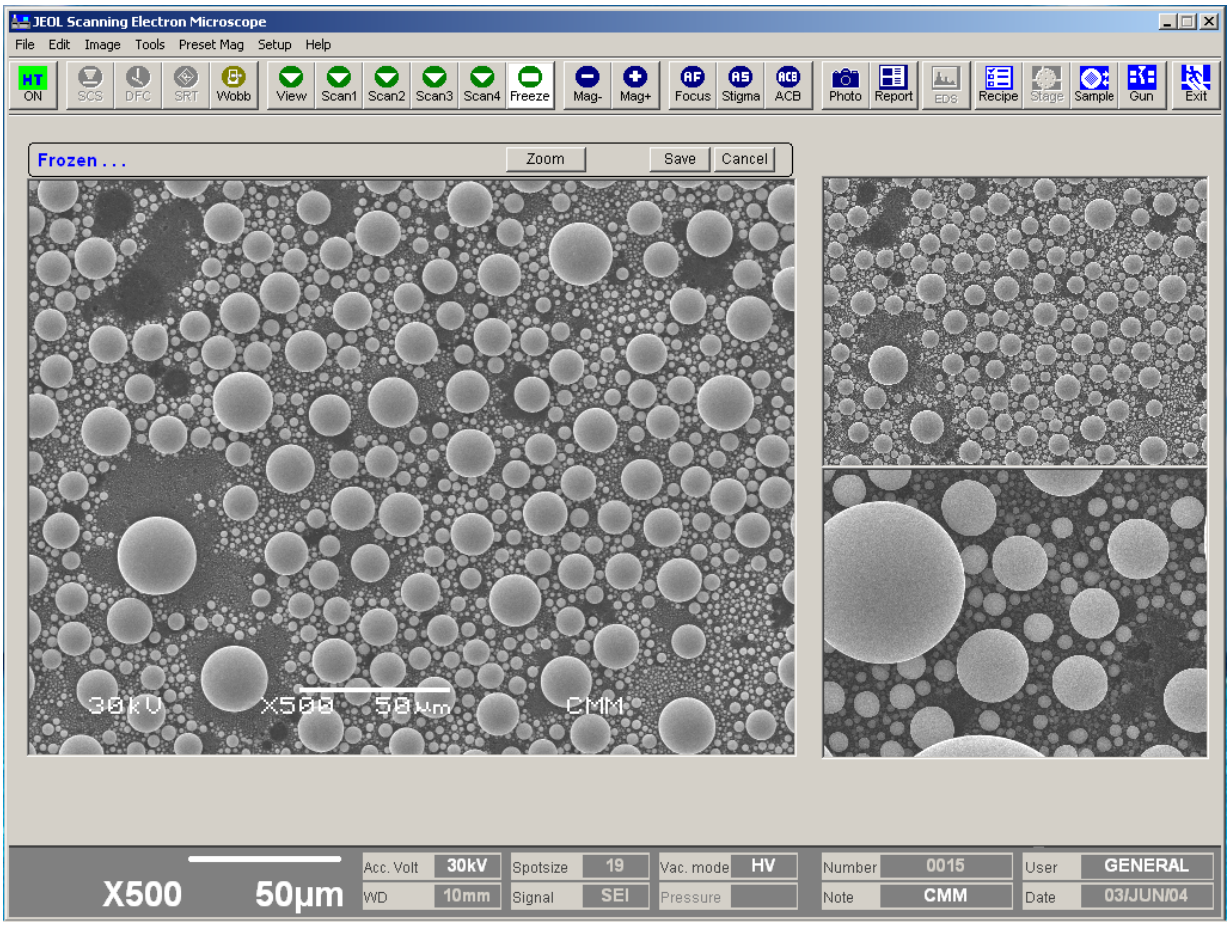
If the SEM software is not responding or is behaving abnormally you can close the application and restart it (PC-SEM).

If this does not work or the computer is locked up you can reboot the computer. If the computer is responding use the software restart (START Menu). If the computer is locked press and hold the power button on the front of the computer until it turns off. Release the button then press it again to restart the computer. (USER:jeol;PASSWORD:jeol).

This should fix nearly all problems unless there was an actual failure.

Do not cycle the power on the entire system (key switch) unless a staff member instructs you to.

JEOL 6060LV GUI



Menu bar
When each menu is clicked, a pull-down menu is indicated. If you click a pull-down menu, the various operation and setup dialog can be executed and/or displayed.

Text icons
When each icon button is clicked, switching of the scan mode, auto-function is started, or an operation window is displayed.

Manual control buttons
Manual adjusting buttons (spotsize, contrast, brightness, etc.) and image size switching button are arranged.

Image display area
A SEM image of 640×480 pixels can be displayed, and the image shift and stage movement can be controlled.

Snap shot image area
Pastes file image or the current image on the image display area, and the stage can be moved (right click for menu)

Active data display
This shows the present situation of the SEM. When each item is clicked, the dialog linked with the item opens.